



# METROPOLIS : metrology in support of precautionary sciences and sustainable development policies

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# METROPOLIS : METROLOGY IN SUPPORT OF PRECAUTIONARY SCIENCES AND SUSTAINABLE DEVELOPMENT POLICIES

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## Résumé

La réalisation de mesures fiables est essentielle pour un développement et une harmonieuse implementation des politiques de développement durable. L'ensemble de la chaîne d'information, de la traçabilité de données à la communication des résultats, comporte une série de facteurs critiques qui jouent un rôle déterminant dans le développement de politiques capables de répondre efficacement aux besoins des citoyens dans les domaines de la santé, de la sécurité et de l'environnement.

Financé par la Commission Européenne sous le 5<sup>ème</sup> programme cadre pour la recherche et le développement, le réseau METROPOLIS réuni 17 pays et 38 participants parmi les organisations et les instituts de recherche les plus significatifs en Europe dans le domaine de la métrologie environnementale, plus DG Environnement dans un rôle de consultation. La présentation ci dessous donne une vue générale des actions et premiers résultats apportés par les différents Groupes de Travail au sein du réseau.

## Summary

Reliable measurements are essential for the development and harmonious implementation of sustainable growth policies. The whole information chain, from traceability of data to communication of results raises challenges that become key success factors in the development of policies responding effectively to societal needs in the fields of health, safety and environment.

Funded by DG Research under the 5<sup>th</sup> Framework Program, the METROPOLIS network brings together 17 countries and 38 participants from the most significant organisations and research institutes dealing with environmental metrology in Europe, plus DG Environment itself in an advisory capacity. An overview of the outcomes and actions taken by the different Work Packages will be object of the conference presentation.

## Introduction

METROPOLIS is a multidisciplinary thematic network funded under the 5<sup>th</sup> Research Framework Programme. Its main goal is to improve the performance of environmental measurement and monitoring systems in support of European policies. The network brings together 17 countries and 38 participants from the most significant organisations and research institutes dealing with environmental metrology in Europe, plus DG Environment itself, in an advisory capacity.

Reliable measurements are essential to manage sustainable development policies and respond effectively to societal needs in the fields of health, safety and environment. Building up the reliability of the whole information chain, from traceability of data to communication of results raises

challenges that are key success factors to the success of environmental policy.

The METROPOLIS initiative stems from the recognition of these priority needs and it is in this framework that METROPOLIS, as a network of metrology experts, operates in order to:

- improve, harmonise and disseminate essential and practical knowledge in environmental monitoring, identify gaps and collaborative know how
- foster the dialogue between those who provide measurement methods and associated services and the users of measurement results
- prepare the ground for the creation of an EU Network of Excellence bringing together the most significant European organisations and institutes in order to improve collaboration and sharing of research programmes across Europe in environmental monitoring.

The work is organised in six scientific work packages co-ordinated by INERIS (7<sup>th</sup> work package). Each work package deals with a different aspect of the measuring chain:

	Leader
1 : Bio-monitoring	University of Munich
2: Methods in analytical chemistry and Reference Materials	Josef Stefan Institute
3: On-line measurements and data-transfer	IVL
4: Quality Assurance and uncertainty assessment	LNE
5: Standardisation	IPQ
6: Communication of results — Support to decision-making	University of Cordoba

The measuring chain illustrated in the picture below is a useful preliminary to a more detailed presentation of the activities carried out by the participants in the network.

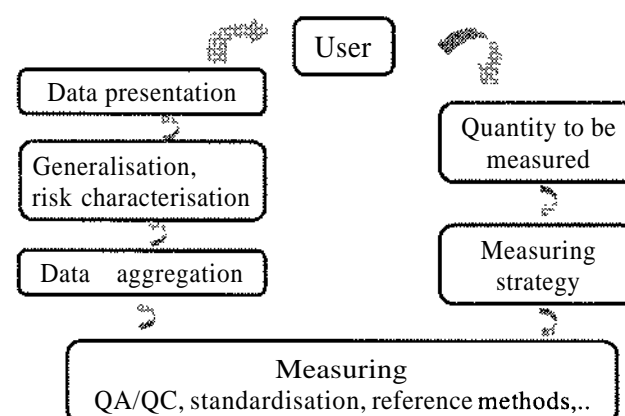


Fig. 1 - simplified scheme of the measuring chain

## **Defining the measuring strategy**

### **Survey on the need for guidance and suggestions for research for a cost efficient and uniform implementation of European policies**

The EU directives call for measurements of several pollutants in air, water and - in the future - soil. However, the directives in some cases give room for interpretation as to what measurement strategy should be used.

Any lack of well-defined measurement strategy in the directives is potentially troublesome because it will induce a risk of non-uniform implementation of the directives. For the practical interpretation of air quality measurements, the European Commission established in 1998 a Guidance Working Group. However, there may be similar issues concerning the directive on water. It is likely that the issue of selecting appropriate and cost-efficient measurement strategies for fulfilling the requirements of EU directives is a matter of concern in all member states. Metropolis could therefore contribute to a uniform implementation of EU directives.

WP3 (IVL, Sweden) is in charge of carrying out interviews with practitioners, national authorities and relevant EU bodies on what they view as implementation difficulties with regard to measurement strategies under existing and expected EU directives. Experts in different sectors of society and in different parts of the EU will be sought through the Metropolis network. Questions about implementation difficulties with respect to measurement strategies under EU directives will also be posted on the Metropolis web site so that anyone who so wishes may contribute to the work. The results will be given in a report, which will list for both existing and expected EU directives, points of concern with either a reference to some available guidance document or with suggestions for further research. The report could also include comparison between member states as to how the directives are implemented on the above-mentioned points of concern.

## **Measuring: the measuring methods**

### **Database on bio-monitoring assays and chemical analytical methods**

The METROPOLIS network will develop a database with a dynamic web interface for bio-monitoring assays and chemical analytical methods. This tool will allow a comprehensive overview of the state of the art, novel techniques, research needs, etc. in the field of environmental measurement. The collaboration between WP1 and WP2 in this task will also allow a more efficient exchange of information between the two communities, the biologists and chemists, since bio-monitoring and analytical instrumental methods will be increasingly complementary techniques in the future.

The first version of the database will appear on the METROPOLIS web site by the end of July. The database will be progressively fed by the METROPOLIS participants. The database will be accessible to the general public for consultation and especially to encourage the submission of data on existing measuring methods and input on on-going projects and research needs.

## **Measuring: Quality Assurance - Uncertainty calculation**

**FAQ on ISO 17025** ISO Standard 17025 is the standard reference which sets, at the international level, the general principles for the accreditation of testing and calibration laboratories. There are many questions about the interpretation of the definitions and requirements contained in ISO 17025. The document may be difficult to translate into practical procedures for use in routine laboratories.

LNE (France) will lead the preparation of a list of FAQs (Frequently Asked Questions) on ISO 17025. The list of FAQs will then be progressively extended thanks also to the input from external users (e.g. testing laboratories). A public forum is already available on the METROPOLIS web site for encouraging the submission of questions from laboratories and other concerned parties. The publication of a first list of questions and corresponding answers is due to be available by September 2003. The list will be progressively updated until the end of the project.

### **Critical analysis of documents and standards for uncertainty calculation**

The "Guide for the expression of uncertainty in measurement" (GUM 13005:1999) is the reference guidance document at EU level for uncertainty calculation, providing the general concept for harmonised estimation of measurement uncertainties in all domains of metrology. Alternatively, the combined effect of several sources may be evaluated by statistical methods, for example, by carrying out the same measurement on a homogeneous and stable sample in a number of different laboratories or in the same laboratory over time.

Many different guidance documents based on the above-mentioned approaches have been produced in order to meet the needs of practitioners in specific domains. However, this has not been done on a systematic basis (by matrix and final use of the measurement result). A number of different methods are applied in common practice for the calculation of uncertainty without a systematic comparison of the results obtained using the different calculation approaches.

The current situation may lead to potential difficulties:

- risk of making an incorrect judgement/evaluation of the competence of a testing laboratory
- confusion among practitioners about the "best" method/guidance document to use for calculation of uncertainty in a given practical situation
- at national level, in some specific areas, legal problems are likely to arise when checking compliance with the limits set by the regulations: if the limit is, for example 10, a measurement result of 9 with an uncertainty of  $\pm 2$  could already be above the limit allowed. The relationship between the approach used for the calculation of the uncertainty and the consequent decisions should be thoroughly investigated in order to provide the best possible support to such critical decisions (need for practical guidelines)
- at EU and international level there is a growing need to compare data from different areas and countries in order to produce an overall view of the current

situation (e.g. status of the environment): comparison of data from different sources/ countries is often not possible today.

NPL (UK) is responsible for carrying out a critical analysis of current guidance documents, standards and selected guidance under development for the calculation of uncertainty in environmental measurements. This analysis will be concluded with the production of a written report with recommendations for new guidance material. In order to ensure as much as possible an efficient exchange of information among the concerned parties, a forum is already open on the web site for the concerted definition, within a group of appointed experts, of the documents to be analysed, the assessment criteria to be used for this analysis and the results of the critical analysis.

A preliminary draft setting out the key proposals that METROPOLIS intends to put forward in the final report as recommendations for new guidance material will be available on the internet (public forum) for discussion with the interested parties at European level.

**PT schemes** In recent years both testing laboratories and accreditation bodies have realised the importance of proficiency tests. LNE is the leader of a discussion forum aimed at exchanging information about the status of current PT schemes in the environmental field in Europe and the needs of the practitioners. The work of LNE will build on the experience gained with other projects and in particular with the EPTIS database, which was launched on the internet site of the BAM (Federal Institute for Materials Research and Testing) in the year 2000.

The number of PT schemes registered in EPTIS is now considerable and it is important to use this database as a starting reference for the work to be carried out by Metropolis on this issue. The results of the exchange of information will be the basis of a written report which will be published on the internet at the end of the project.

#### **Reference materials (RM) production and use**

Many guides and books are available on "use of reference materials". An ISO guide on the use of "certified reference materials" is also available. However, practitioners claim that it does not respond adequately to their needs and it is somewhat outdated. Moreover, reference materials of different quality levels are available on the market (i.e. certified reference materials and non-certified reference materials). Practitioners find it difficult to find their way around all these products when they need to find the reference material that satisfies their demands in everyday practice. The following questions often arise:

- when and how to use reference materials? Should their application be generalised or only limited to a number of specific situations? If yes, which ones? It is important to define the applications for which reference materials are needed
- what are the criteria to choose a specific reference material (quality needed) according to specific demands?

JSI (Slovenia) intends to produce in collaboration with UBA (Germany) a guidance document for the proper use of reference materials, specifically focused on the use of reference materials in environmental measurements. JSI

will focus on the aspects related to the use of RM, whereas UBA will concentrate on the aspects related to their production. The work already carried out in other projects will be taken into consideration in order to build on this experience and avoid duplication of work. A "Table of Contents" for the document is already available on the internet for discussion, in order to improve the final result of this work.

#### **Measuring; Standardisation**

WP5 will interact with the other work packages and external concerned parties as regards:

- co-normative and pre-normative research needs: a survey (via internet forum) is under way on the current problems and research needs within CEN and ISO relevant WGs and TCs, in particular those linked with standardisation process
- exchange of information about the implementation of the Measurement Instrumentation Directive (MID): IPQ (Portugal) will lead actions aimed at identifying difficulties and the need to extend the scope of this directive in the environmental field (at present the MID Directive considers only exhaust gas analysers in the area of environmental monitoring instruments)
- exchange of information about experiences in the definition of standards for the certification of instruments used in the environmental field. MCERT in the UK is so far the most significant experience in Europe in the definition of procedures for the certification of instruments used in environmental monitoring. IPQ (Portugal) intends to carry out an exchange of information (e.g. via internet forum) in order to analyse the experience of MCERT in the UK, as a starting point for the development of EU standardisation procedures and to exchange information about other experiences in Europe. The results of the discussion will be published in a written report at the end of the project
- support for starting the standardisation process and traceability chain of recommended measuring methods: WP5 intends to use the database and the deliverables produced by the other WPs as a source of information for identifying measuring methods that should be recommended/ supported in the development of the standardisation process and the necessary traceability chain
- exchange of information about the needs among practitioners as to the revision of the International Vocabulary on Metrology. WP5 intends to provide some support in the revision of this document by exchanging / collecting information about the needs of practitioners in this respect.

#### **Data aggregation/ presentation and data distribution**

**Workshop on data presentation and data distribution** Presenting data that are both scientifically correct and capable of being understood by a larger audience is a challenge. Even though our graphs and tables may be perfect, their presentation on an internet page can

affect the public's interpretation dramatically. Tests have shown that more than 50 % of users can not perform or repeat simple tasks such as buying tickets or goods on the internet. The solutions are just not adapted to their users/customers.

Possible users of environmental data will range from scientists to decision-makers and the general public. Hence the users will have very different backgrounds for understanding data presentations. A scientifically correct presentation that will be easily understood by experts can be misinterpreted by the general public. Basic understanding of usability of relevant services is vital in order to gain useful knowledge in the field of data presentation and data distribution.

Standardisation of presentations is another aspect to be considered. A key challenge in any data presentation is to communicate the information in such a way that all receivers understand and interpret the information equally.

In conclusion, the questions to answer are:

- what are the correct scientific ways to visualise measurement data (e.g. from on-line measurements)?
- what are the best ways to visualise data for different user groups?

NILU (Norway) will organise a workshop on this topic in September in Goteborg. The outcomes of the discussion will be available on the internet and will be the basis for the preparation of a "Guidance tool for data presentation and distribution in the form of a written report and/or interactive web pages".

**Guidance for the use of Geographical Information System (GIS)** A GIS is a powerful computer-based tool for manipulating, storing and presenting data within a spatial framework (e.g. on a map). A GIS is composed of hardware, software and most importantly datasets. Due to its versatile nature, a GIS can be used to aid the whole metrology process from data specification and collection to data storage and management through to data manipulation and presentation. Limitations of GIS use include its being a largely 2-D based tool (although this is changing) and that it can be resource intensive both in terms of data costs and infrastructure as well as data manipulation. However data costs have reduced significantly and many problems associated with data manipulation can be avoided by using standardised, 'GIS friendly', data formats. Mindful of the limitations of a GIS (i.e. full considerations of scale, accuracy and intended use are required to ensure it is fit for purpose and able to add insight to the environmental measurement process), the perception is that GIS usage is not routine and that potential uses of this tool in environmental monitoring have not been fully explored.

HSL (UK) will produce a guidance document on the role and current gaps in the use of GIS in environmental monitoring. A first draft of the document will be available on the internet web site for comments by the end of this year. A draft "Table of Contents" is already proposed on the METROPOLIS web site for discussion.

### **Communication of results and support to decision-making**

**Decision-making in the presence of a high degree of uncertainty** Decision-making on a more or less complex issue is strongly influenced by the uncertainty. One source of uncertainty is the measurement itself, which can never be 100% exact. Moreover, decisions on important issues are rarely (or never) based on a single type of measurement. They usually involve multiple measurements, the use of different types of measuring devices (i.e. different design and physical principles) and the application of different mathematical models, which are therefore characterised by a different degree of uncertainty. Other sources of uncertainty are the sampling step and the time coverage (duration of the individual measurement compared to the reference time period).

When making decisions, decision-makers must be aware of the degree of uncertainty in the data on which they are basing their decisions. The way of representing uncertainty to the public and decision-makers must be understandable whilst being consistent with the measurement result. In other words, the form of the final information should preserve the degree of uncertainty existing in the source measurements whilst being understandable to the decision-makers and the public.

RISOE (Denmark) proposes to carry out a critical analysis of "the ways in which uncertainty is represented in relation to the needs of decision-makers". Such critical analysis would include the following steps: 1) a survey of existing theories of decision-making, focusing in particular on "non-conventional" - precautionary-theories of decision-making that take into account the uncertainty; 2) since any decision-making theory imposes certain constraints on the input parameters, an analysis will be carried out, with the help of practical examples and in collaboration with WP4, of the kinds of uncertainty representation in measurements which are consistent with the existing decision-making theory/ies; 3) a final report with the results of the investigation, conclusions and recommendations for future research.

The first intermediate deliverables will be produced by the end of November 2003. These intermediate products will be made available on the internet for discussion. The final report is due to be published by June 2004.

**Workshop: experience with the implementation of the air quality policy** European environmental legislation can only be successful if backed by local authorities and implemented by individual citizens. Experience gained in the application of air quality policy shows that the most effective steps in the quest for better air quality are the rising of public awareness and the development of local abatement strategies. Of all the effects of air pollutants, it is the impact on human health that attracts the keenest interest among the public. Raising their awareness of the risks inherent in air pollution can therefore encourage them to behave in environmentally friendly ways, to lend active support to environmental policy and to democratise environmental decision-making. JRC ISPRA proposes to organise a two-day seminar on experiences with local abatement strategies involving citizens, the development of air pollution and health information systems and awareness-raising projects.

### **The mismatch between requested and delivered data**

The final aim of the data delivered by testing laboratories is to provide concrete support in the decision-making process. It is therefore of the utmost importance to ensure not only consistency between the information delivered by the testing laboratory and the actual chemical content in the sample subject to analysis, but also between the analytical information delivered by the laboratory and the information needed by the client.

A lack of consistency between required and delivered analytical information negatively affects the usefulness of the information generated by the laboratory. Sometimes analytical information about a wide variety of pollutants is delivered, whilst there is only a need to know an overall amount or an index. In another case, an analytical report providing information, for example, about heavy metals, will not be sufficient in most cases to define the toxicity of the sample (analytical information about specific single species present in the sample will be necessary). A lack of consistency between required and delivered analytical information may also derive from the analytical method used and its properties (e.g. rapidity, accuracy or precision).

A careful assessment of the information typically requested by users nowadays shows that qualitative responses account for a substantial portion. Private companies and government bodies, toxicological institutes, industrial firms, etc. are increasingly interested in getting general answers simply based on binary yes/no responses rather than on detailed, discriminated chemical information. For example, an environmental body may be interested in knowing whether seawater is contaminated by hydrocarbons within the meaning of the legislation rather than in getting a long list of aliphatic and aromatic hydrocarbons, including their individual concentrations and uncertainties.

The University of Cordoba (Spain) is responsible for organising an exchange of information about the 'consistency between required and delivered analytical information' and about the 'role played by qualitative data and global indices in the relationship between environmental testing laboratories and clients'. Such an exchange of information would start from a preliminary draft report with a list of representative examples illustrating the problems, reasons and consequences of the mismatch often encountered in current practice between the needs of the final users and the analytical data delivered by the testing laboratories. The draft report would remain available for discussion in an internet forum, which would allow an exchange of information among metrology experts about the content of the draft report and provide the basis for the preparation of the final report.

### **Expert judgement approaches for measurements that are not performable in practice**

Decisions with regard to evacuation, decontamination and food bans must be taken on the basis of predictions of environmental transport of pollutants, contamination through the food chain, carcinogenic effect and the like. These predictions use mathematical models containing scores of uncertain parameters which are measurable in principle, but which cannot be measured in practice because of their costs, technical difficulties, the uniqueness

of the situation or ethical problems. Decision-makers want to take, and want to be perceived to take, these decisions in a rational manner. The question is: how can this be accomplished in the face of large uncertainties? Structured expert judgement is a way to properly address this issue. This basic tool is probabilistic risk analysis which is actually a systematic precautionary science serving the needs of sustainable development along with other objective measurements. These judged measurements need to undergo a standardisation process to the same extent as do conventional measurements.

RISOE (Denmark) proposes to organise an exchange of information on the "role of expert judgement approaches for measurements that cannot be performed in practice". Such an exchange of information would start from a preliminary draft report. The draft report would remain available for discussion in an internet forum, which would allow an exchange of information among metrology experts (within or outside METROPOLIS) about the pertinence of expert judgements as substitutes for measurements that cannot be performed in practice. A final report on the "role of expert judgement approaches" would be prepared as a result of the proposed exchange of information.

### **Conclusions**

As a final outcome Metropolis would like to ensure that an overall consistent message is conveyed to the final users. To this purpose TNO (The Netherlands) will produce in collaboration with INERIS a document illustrating how the tasks and the final outcomes of Metropolis interrelate and how they can respond to the needs of the different categories of users.

Sharing information and improving the dialogue between the concerned parties (horizontal debate) is one of the main goals of METROPOLIS and it is the basis for the definition of future research projects. The current participants represent the core of the network, but Metropolis as a network is open to offers of additional expertise. Organisations interested in being more directly involved in the activities of this network are invited to contact the Metropolis co-ordinator and visit the metropolis website (<http://www.metropolis-network.net>). The metropolis network will be glad to offer access to the restricted-access area of the web site to organisations willing to make an active contribution.